



## **Simultaneous gaze and motor imagery hybrid BCI increases single-trial detection performance: a compatible incompatible study**

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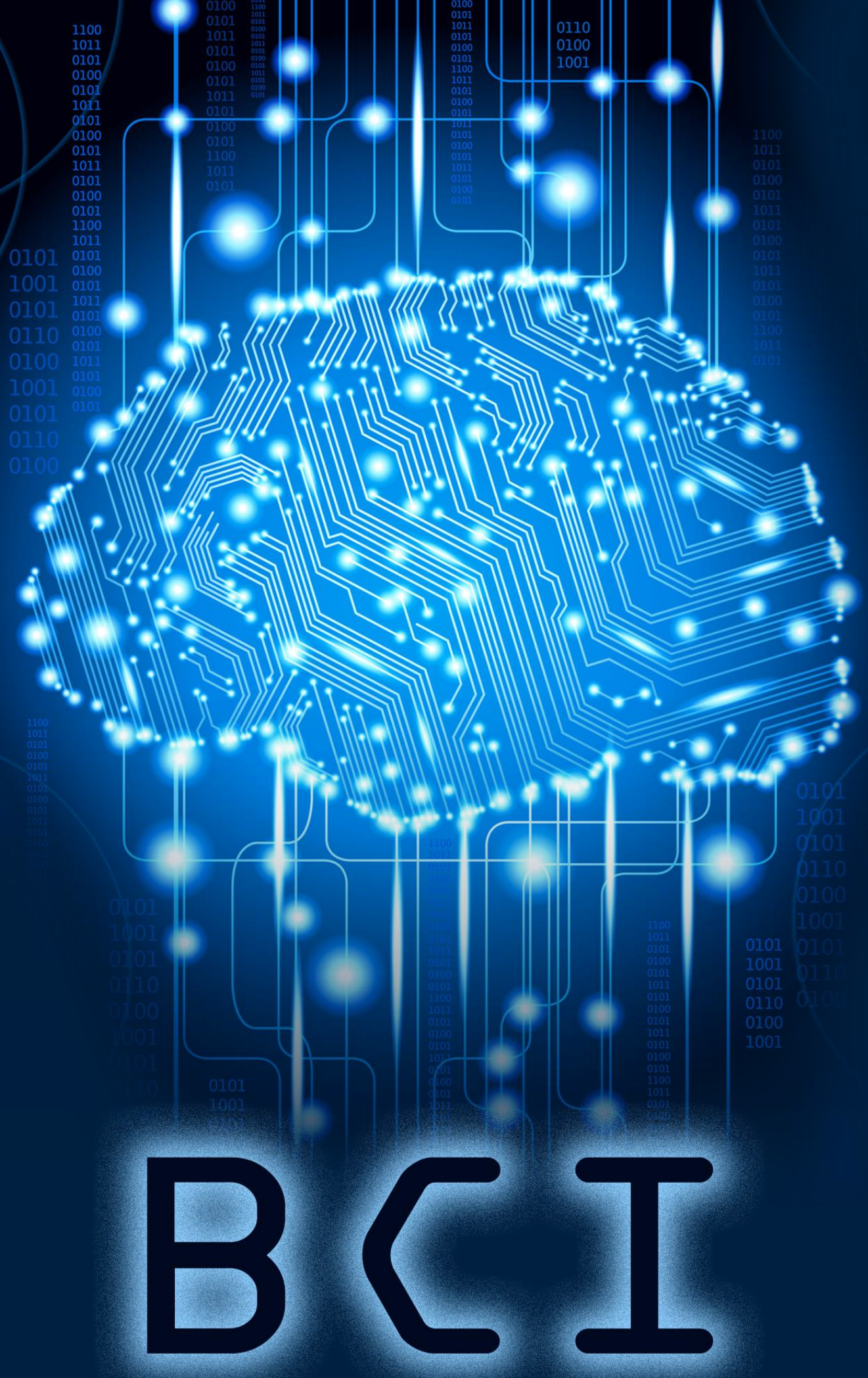
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# Simultaneous gaze and motor imagery hybrid BCI increases single-trial detection performance: a compatible-incompatible study



# BCI

## 1. AIM

- To develop a simultaneous hybrid brain-computer interface (BCI) that combines an event-related de-synchronization (ERD) BCI and an eye tracker, and improves performance by increasing the number of commands.

## 2. INTRODUCTION

- BCI provides a novel means of communication. This can be achieved by measuring electroencephalogram (EEG) signal over the sensory motor cortex of a person performing motor imagery (MI) tasks.
- However, the performance of BCI remains currently too low to be of wide practical use. A hybrid BCI system could improve the performance by combining two or more modalities such as eye tracking, and the detection of brain activity responses [1].
- Incorporating incompatible conditions between gaze direction and MI may involve errors in the hybrid BCI, while increasing the number the choices [2].

## 3. KEY QUESTIONS

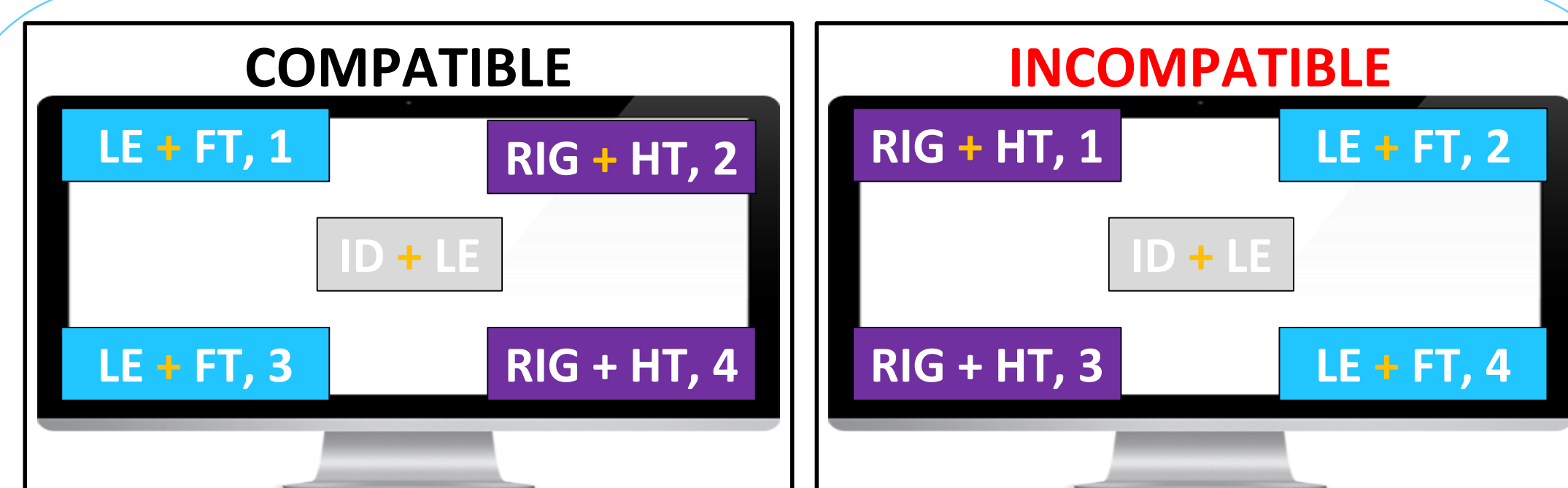
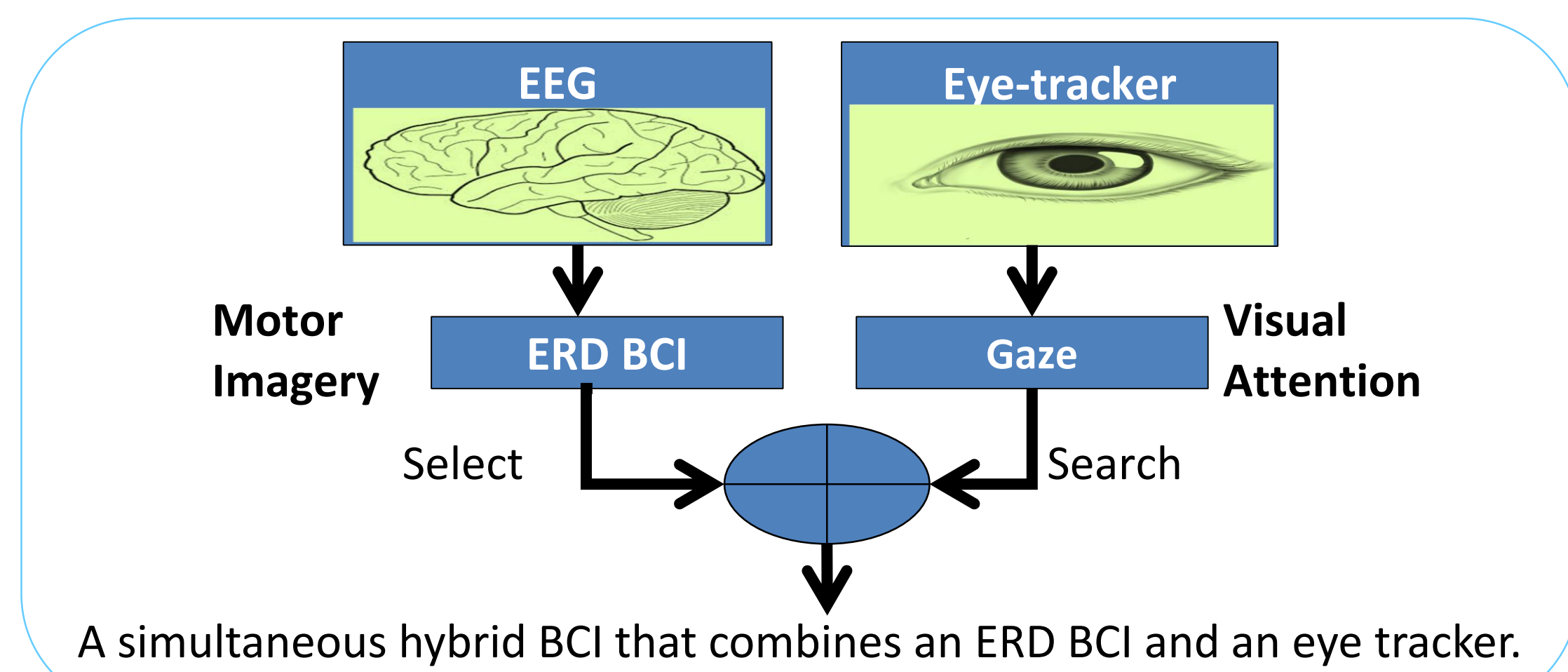
- Do the number of command improve by combining of two different modalities?
- Does the combination of various modalities largely depend on the accuracy of each modality?
- Does the orientation between gaze and motor imagination depend on GUI experimental design?
- Does the number of choices improve in hybrid BCI?
- Do the false positive selection of eye-tracker reduce by BCI?

## 4. HYBRID BCI EXPERIMENTAL PROTOCOL

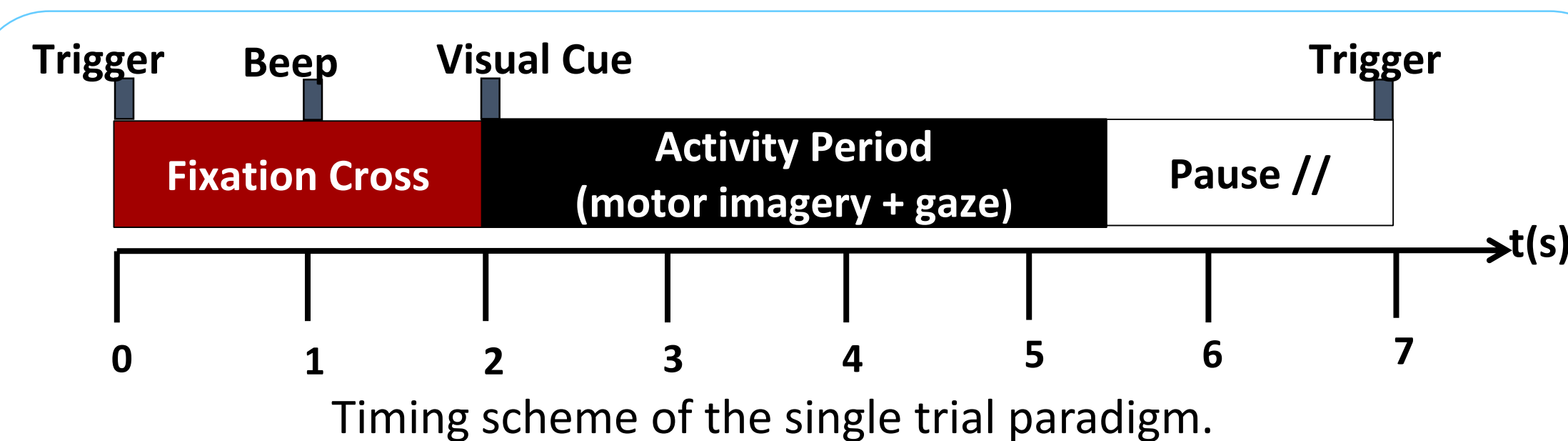
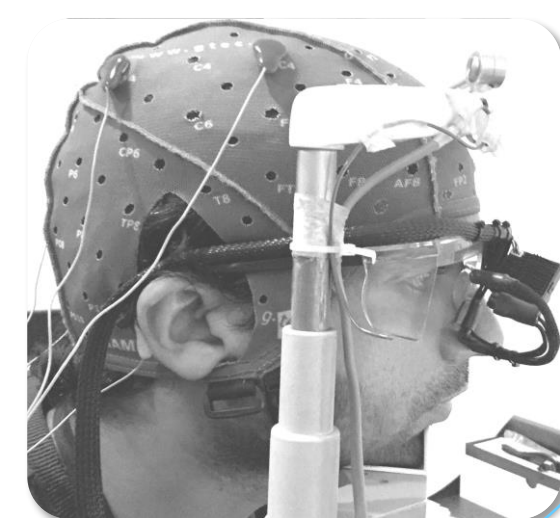
- Single-trial detection for standard, compatible and incompatible conditions, using support vector machine (SVM) classification method.
- Seven consenting healthy male subjects participated in the study.
- Three conditions varied in two classes of motor imagery and four classes of gaze for single-trial detection.
- For each subject, a session with 40 trials was recorded.
  - Standard (LM vs RM)
  - Compatible (LM  $\cap$  LS) vs (RM  $\cap$  RS)
  - Incompatible (LM  $\cap$  RS) vs (RM  $\cap$  LS)

Where LM= left MI; RM = right MI; LS = left computer screen; LR = right computer screen;  $\cap$  = combination of the two conditions.

## 5. HYBRID BCI MODEL



- Compatible and incompatible state of imagining right and left hand movements with four gaze coordinates (1, 2, 3, 4).
- \*RI+GHT / LE+FT = Stimulus that requires right / left hand MI, + = Fixation point
- The positions of the two bipolar channels (C3, C4) and eye-tracker.



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- Y. K. Meena, H. Cecotti, K. Wong-lin, and G. Prasad, "Towards increasing the number of commands in a hybrid brain-computer interface with combination of gaze and motor imagery," in 37th annual int. conf. of the IEEE Engineering in Medicine and Biology Society, 2015.

## 6. SIGNAL PROCESSING AND CLASSIFICATION

### Gaze

- Eye-tracker signals were digitally sampled at 128 Hz by Arrington Research Eye Tracker system.
- Record : gaze x, gaze y, time, trigger, and label indexes (1,2,3,4)

